What is claimed is:

CLAIMS

1. A method of correcting data frames for dynamic phase errors in magnetic resonance imaging comprising the steps of:

a) acquiring a plurality of high-resolution data frames,

b) acquiring with each high-resolution data frame a low-resolution phase reference navigator, and

c) rephasing each high-resolution data frame in *k*-space with a convolution with the Fourier transform of the phase conjugate of the low-resolution phase reference navigator.

2. The method as defined by claim 1 wherein step c) includes the steps of:

c1) calculating for each data frame a Fourier transform of a phase conjugate of the phase reference navigator as a refocusing kernel for the data frame, and

c2) convolving in *k*-space the high-resolution data frame with the refocusing kernel to phase correct the high-resolution data frame.

3. The method as defined by claim 2 wherein step c) utilizes a gridding reconstruction of each high-resolution data frame.

4. The method as defined by claim 3 wherein the acquired MRI data, d, is:

$$\mathbf{d} = \mathbf{GFPm} = \mathbf{RPm}$$

where $\mathbf{d}$ is a $CR \times 1$ vector containing the *k*-space data, $\mathbf{m}$ is a $N^2 \times 1$ vector containing the object magnetization in Cartesian coordinates, and $\mathbf{P}$ $(CN^2 \times N^2)$, $\mathbf{F}$ $(CN^2 \times CN^2)$ and $\mathbf{G}$ $(CR \times CN^2)$ are matrices respectively representing image-space phase corruption, discrete Fourier transform, and resampling from a Cartesian grid onto the *k*-space trajectory.

5. The method as defined by claim 4 wherein the reconstructed image is a least squares estimate:

$$\begin{aligned}\hat{\mathbf{m}} &= (\mathbf{P}^*\mathbf{R}^*\mathbf{RP})^{-1}\mathbf{P}^*\mathbf{R}^*\mathbf{d}\\ &= \mathbf{M}^{-1}\mathbf{P}^*\mathbf{R}^*\mathbf{d}\end{aligned}$$

where * denotes conjugate transpose.

6. The method as defined by claim 5 wherein the least squares reconstruction is estimated as:

$$\tilde{m} = \mathbf{P^*R^*d}.$$

7. The method as defined by claim 6 wherein *k*-space refocusing of each data frame includes:

initialize a zero-filled $N \times N$ matrix (which will accumulate the refocused spectrum),

for each interleave:

(a) Reconstruct the navigator data in *k*-space ($n \times n$),

(b) Zero-pad (a) by a factor of 2 ($2n \times 2n$),

(c) Inverse Fourier transform (b),

(d) Calculate the phase conjugate of (c),

(e) Fourier transform (d) (to get the refocusing kernel),

(f) Reconstruct the high-resolution data frame in *k*-space at the final image resolution ($N \times N$),

(g) Convolve (f) with (e) (refocusing step),

(h) Add (g) to the sum accumulating in step (1),

inverse Fourier transform the cumulative sum from (h) to get the refocused image.

8. The method as defined by claim 7 wherein step a) and step b) include acquiring information relevant to time-varying data corruption, and ordering of data frames based on this information thereby promoting smooth, non-periodic modulation of data in the spectral domain.

9. The method as defined by claim 7 and further including before step (c) the step of:

(b1) weighting each image-space sample in the plurality of data frames by magnitude of the low-resolution phone reference navigator acquired therewith.

10. The method as defined by claim 9 wherein

$$\mathbf{Qd = QRPm}$$

where Q is a preconditioning matrix that provides desired image-space weighting.

11. The method as defined by claim 10 wherein least-squares solution, $\hat{\mathbf{m}}_Q$, is given by:

$$\hat{\mathbf{m}}_Q = (\mathbf{P^*R^*Q^*QRP})^{-1}\, \mathbf{P^*R^*Q^*Qd}.$$

12. The method as defined by claim 1 and further including the step of:

d) summing the phase-corrected high resolution data frames.